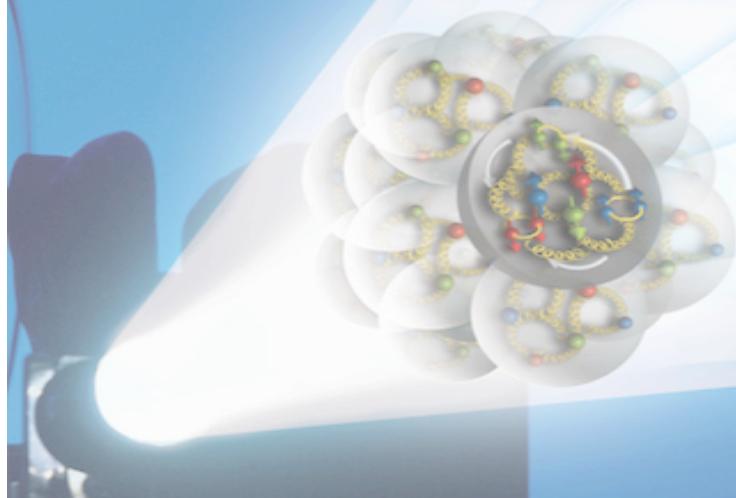


# EIC eRD11 Simulation

Xiaochun He & Liang Xue  
Georgia State University



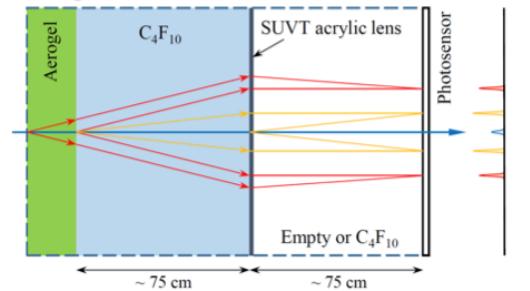
# Introduction

- GSU group was invited to join a detector development R&D project for the EIC's forward region particle identification. This project is led by Yi Qiang (JLab) and Hubert van Hecke (LANL).
- The main focus of the GSU group is to work on detector performance simulation using Geant4.
- A brief report of the current simulation effort is given here. The real work is done by Liang Xue and a new graduate student (Cheuk-Ping Wong) in our group.
- We hope that the outcome from this project could be potential useful to ePHENIX.

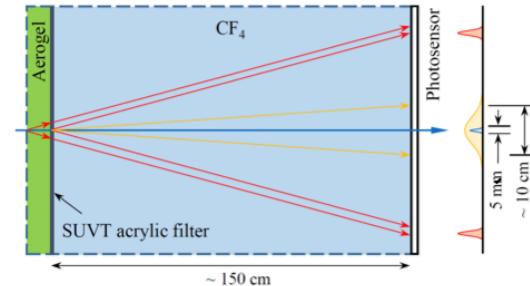
# The eRD11 Project

- Funded by EIC Generic R&D to investigate the technology of RICH detector for the hadron particle identification in the forward region.
- Both the dual-radiator RICH option and a modular RICH concept will be investigated and the associated special optics design will be carried out.
- A newly developed Large-Area Picosecond Photo-Detector (LAPPD) using renovated Micro-Channel Plate (MCP) technology will be evaluated as the readout of the RICH detector.
- The goal of this project is to determine the best detector technology and to provide a conceptual design of the RICH detector for EIC.

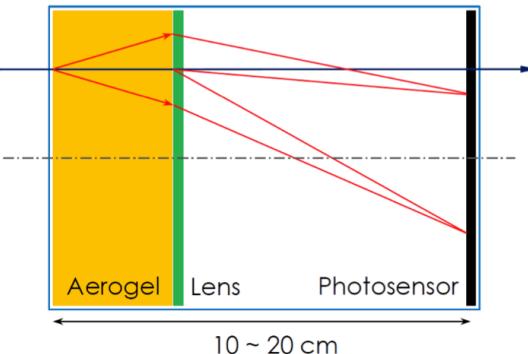
Dual Radiator:



Proximity Focusing

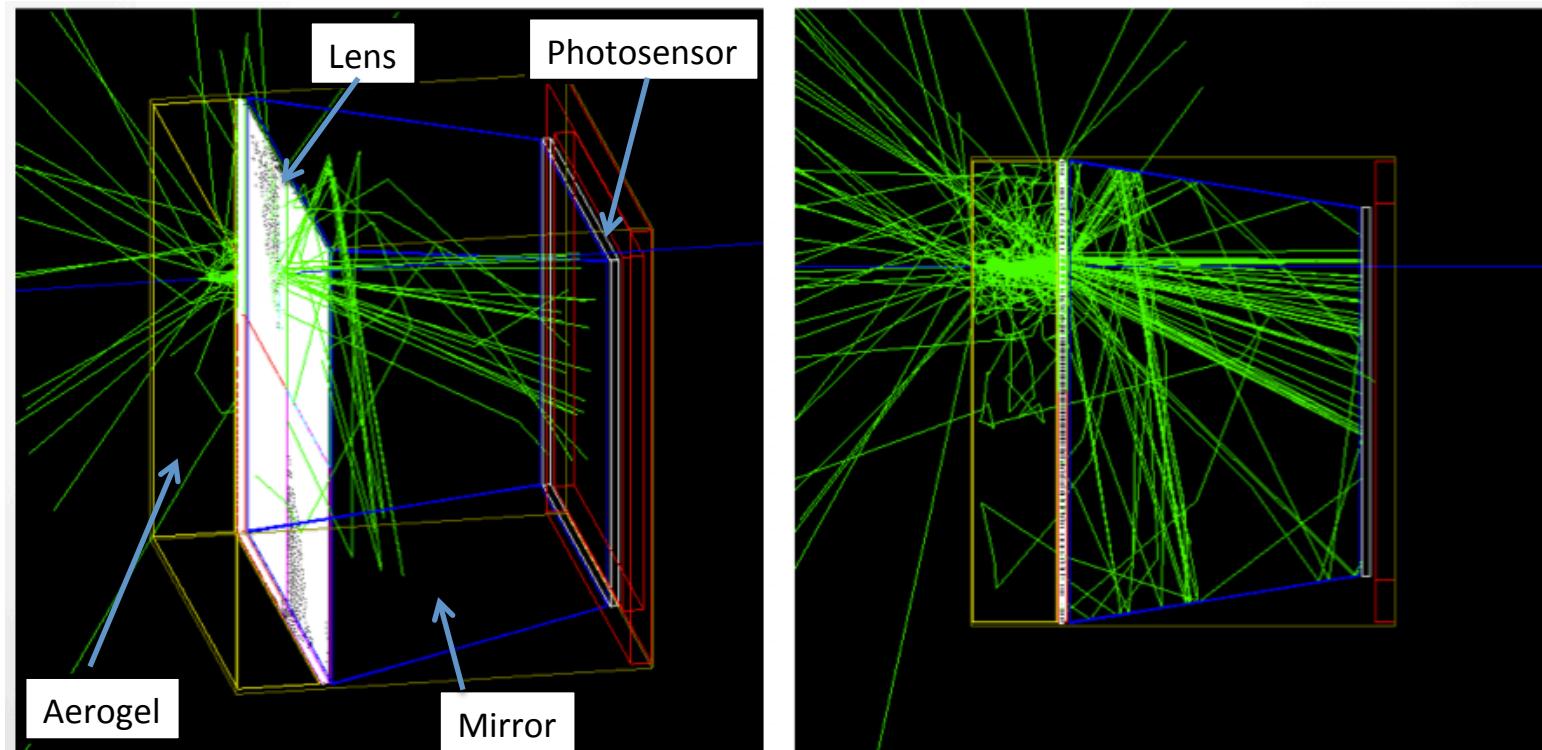


Modular RICH:



# Standalone GEANT4 Simulation

- Standalone GEANT4 simulation has been implemented by Hubert Van Hecke for a modular conceptional RICH detector



[http://p25ext.lanl.gov/hubert/eic\\_rich/modular/agel\\_sim.html](http://p25ext.lanl.gov/hubert/eic_rich/modular/agel_sim.html)

# Modular RICH in GEMC Framework

## 1) A block of aerogel.

- SiO<sub>2</sub>, 0.02 g/cm<sup>3</sup>
- Refractive index: n=1.025

## 2) Fresnel lens

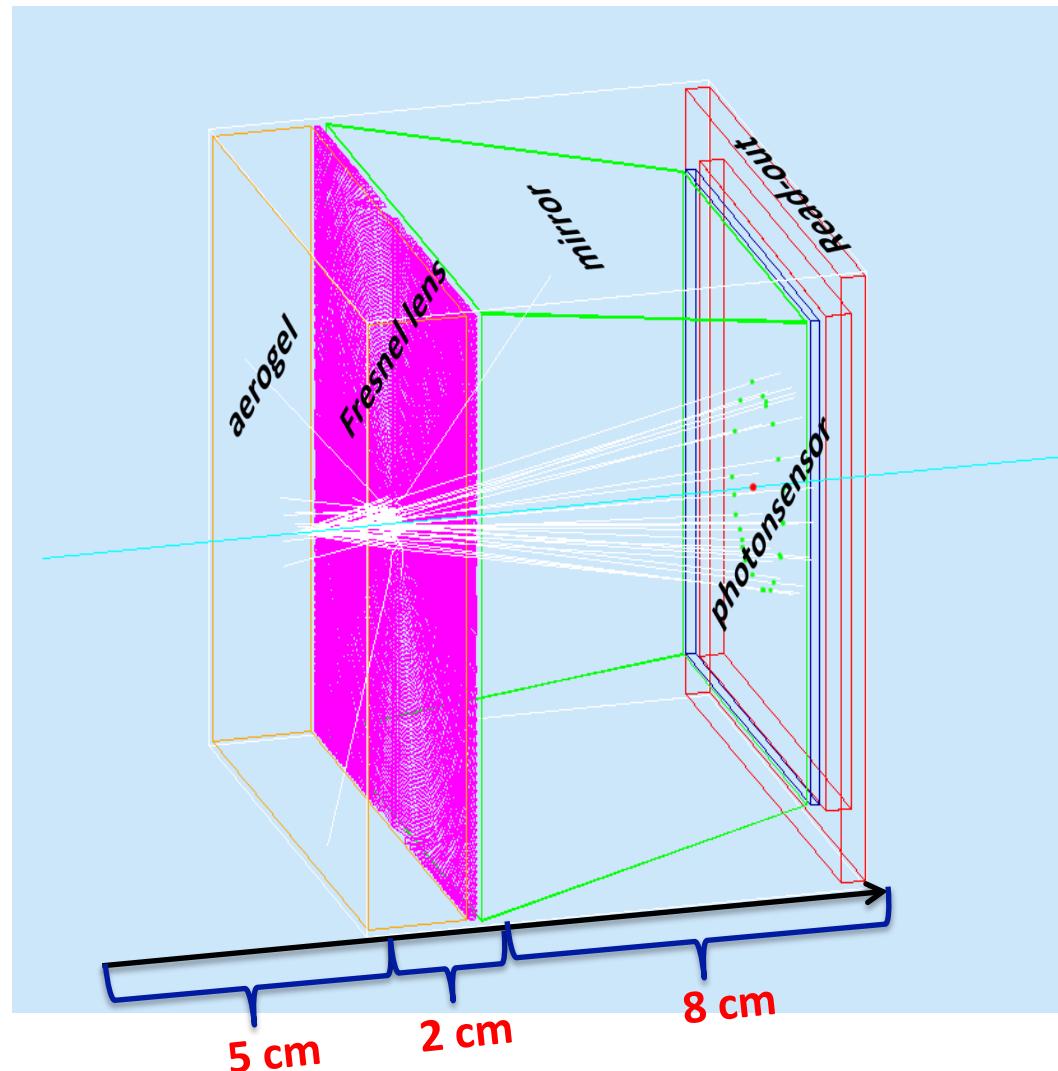
- Acrylic, C<sub>5</sub>H<sub>8</sub>O<sub>2</sub>, 1.19 g/cm<sup>3</sup>
- Four sections, G4Polycon
- 100 grooves, good focusing

## 3) Mirrors

- Four sections: front, back, top and bottom
- Reflectivity index : 0.95

## 4) Photosensor and read-out

- Block of aluminum

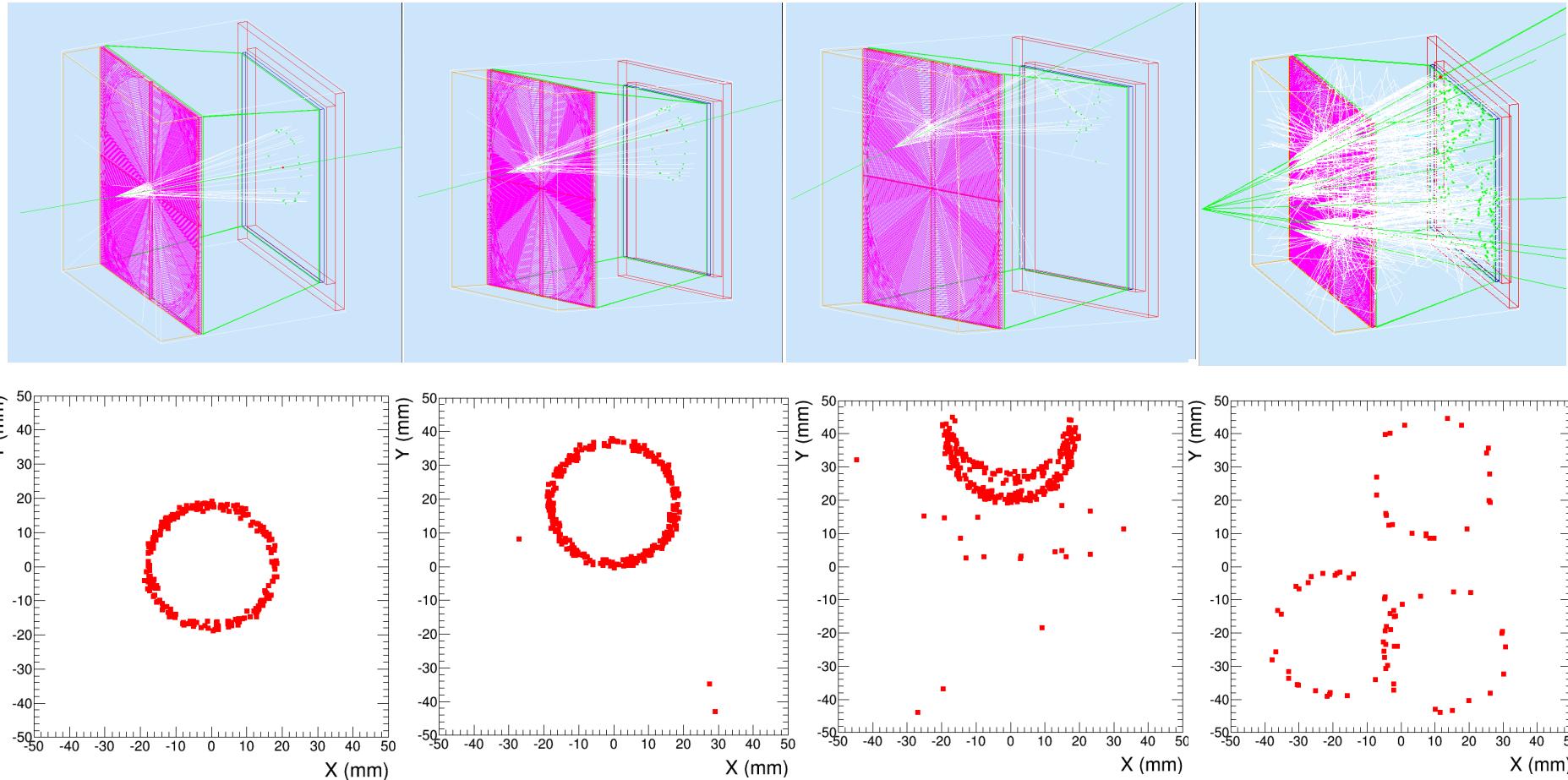


# Modular RICH Performance Study

The following slides were prepared by Liang Xue at a local weekly meeting last Friday.

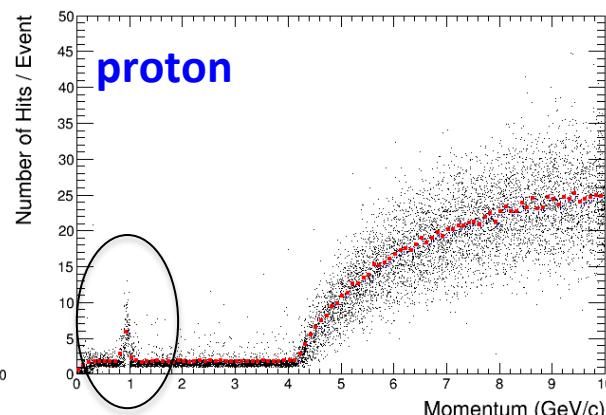
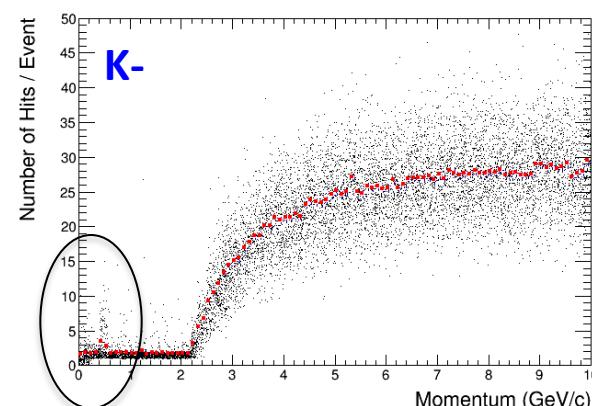
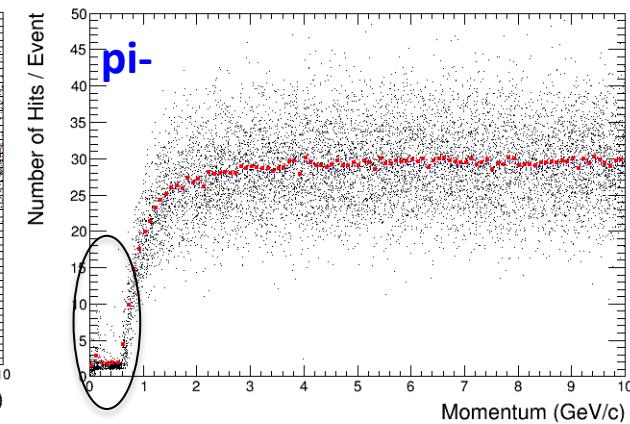
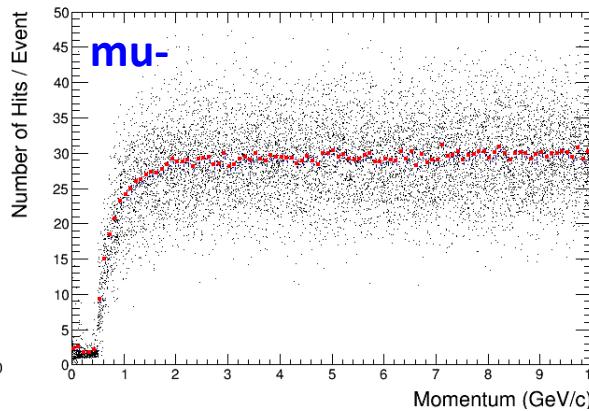
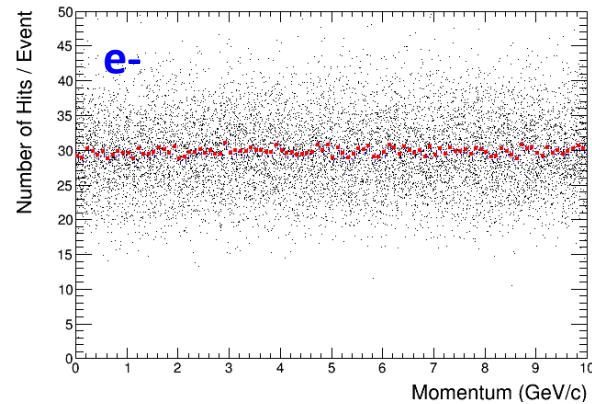
# Cherenkov Radiation Rings

- 5 GeV muons, 10 events, shooting at various angles
- Perfect rings even at different shooting angles



# Detector Performance: Optical Hits

- 10 k single e-, mu-, pi-, K-, and protons are launched along the optical axis (Z axis).
- Total number of optical hits on the photosensor is studied, maximum hits per event is ~ 30.
- Muons start to have Cherenkov radiation from ~0.45 GeV, pion from 0.6 GeV, kaon from 2.2 GeV, proton from 4.2 GeV.

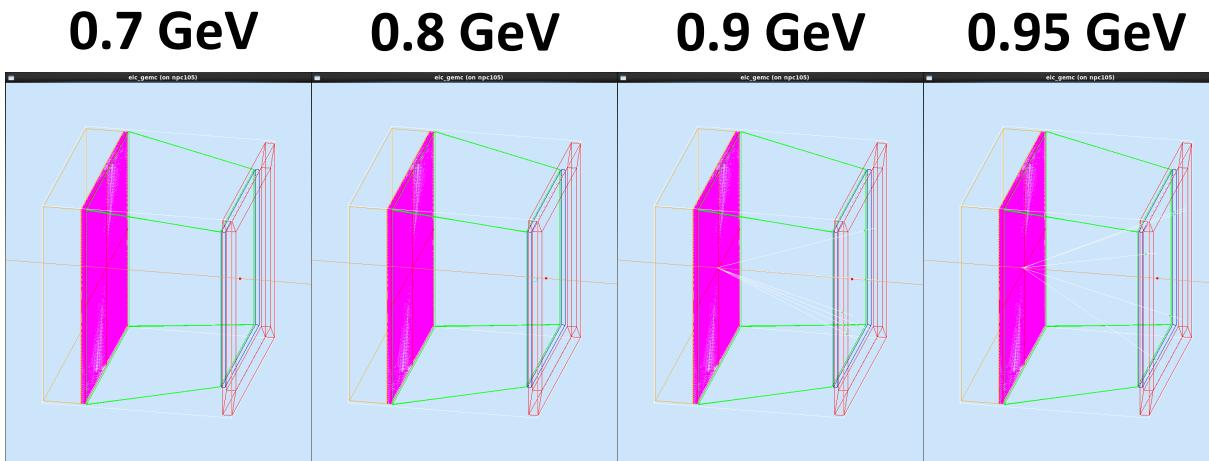
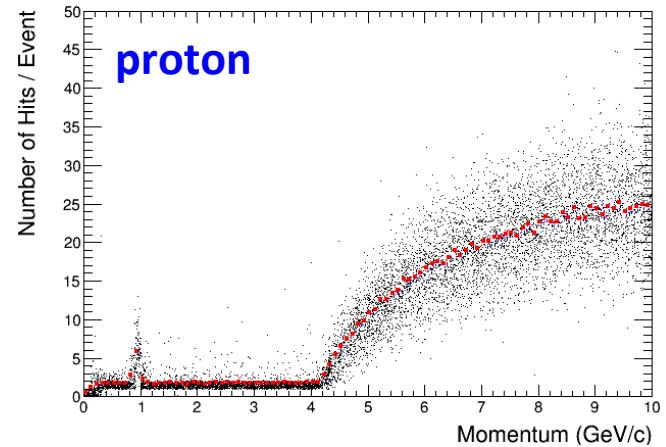


When  $P \sim \text{mass}$  ( $\pi^-/K^-/\text{proton}$ ), the total of optical hits per event has dramatically increase,

**why ?**

# Detector Performance: Optical Hits (Cont)

- 10 k single e-, mu-, pi-, K-, and protons are launched along the optical axis (Z axis).

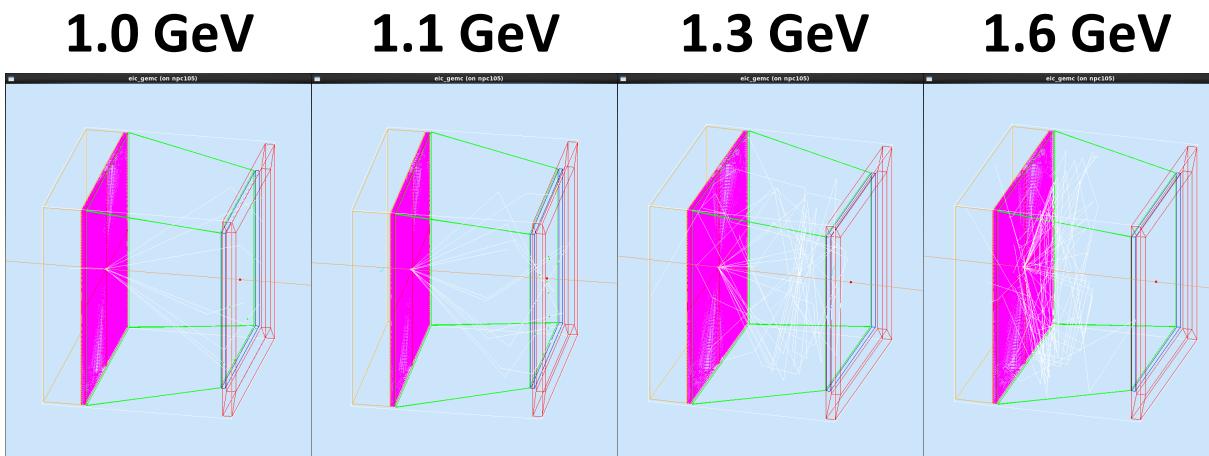


Fresnel lens:

- Acrylic, C<sub>5</sub>H<sub>8</sub>O<sub>2</sub>, 1.19 g/cm<sup>3</sup>
- Refractive index: n = 1.5
- Cherenkov radiation threshold:

$$v = c/n$$

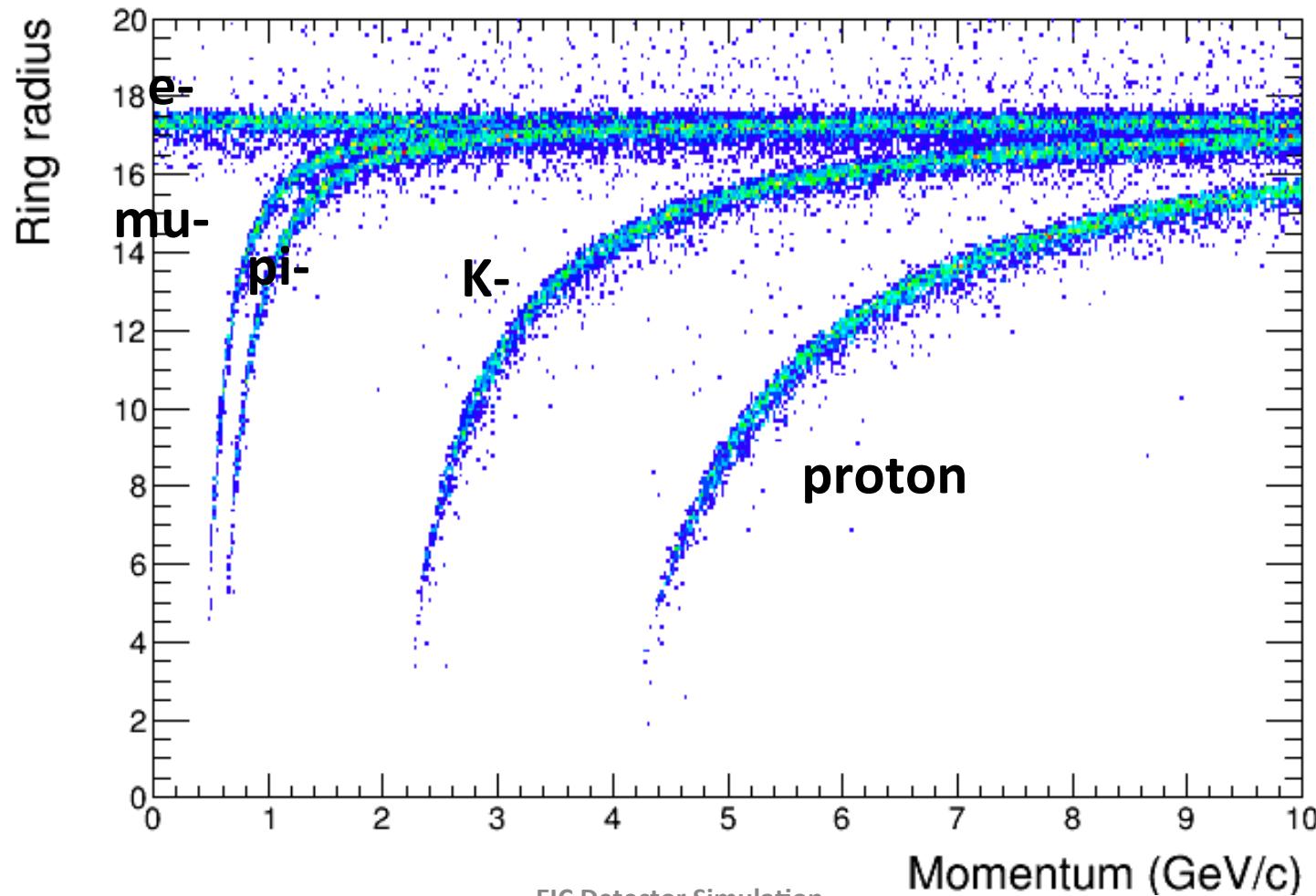
$$p = mv = \frac{m_0 v}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{m_0 c}{\sqrt{n^2 - 1}}$$



Threshold momentum is  $\sim 0.894 \times M$

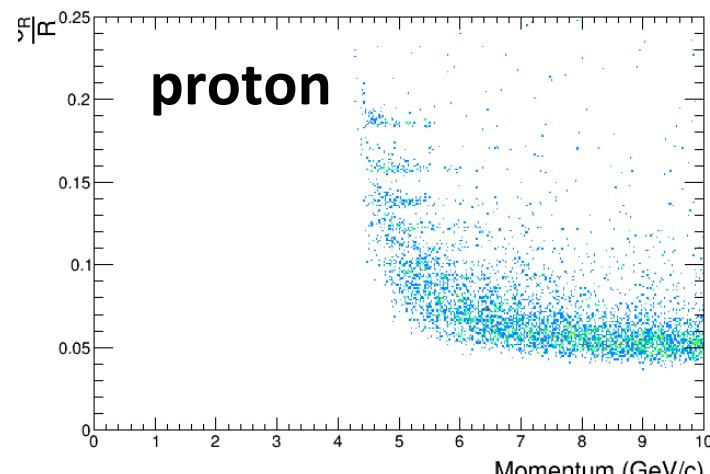
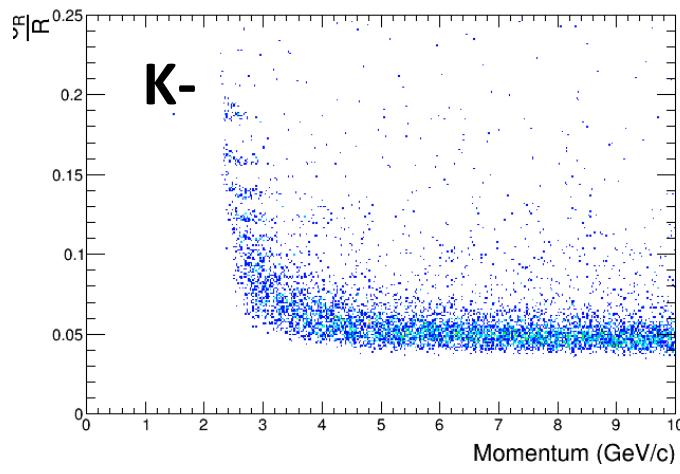
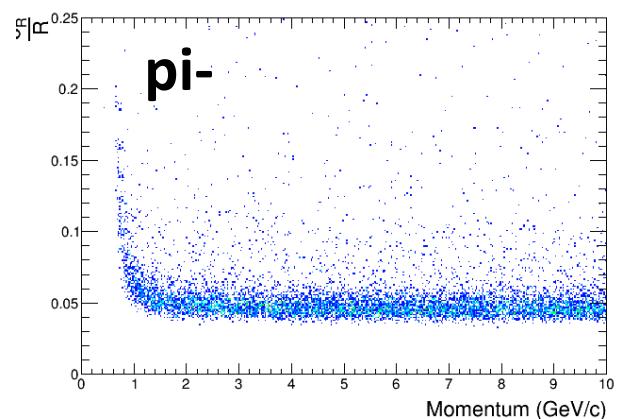
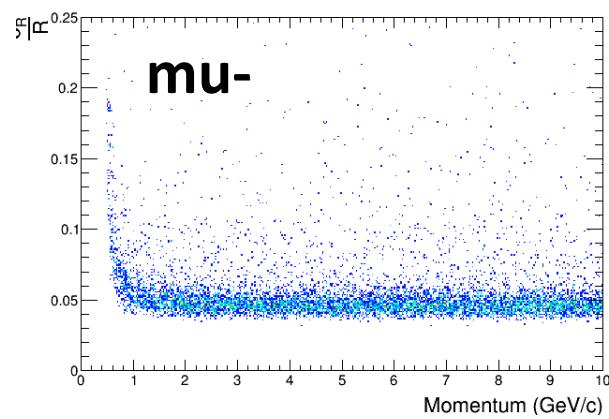
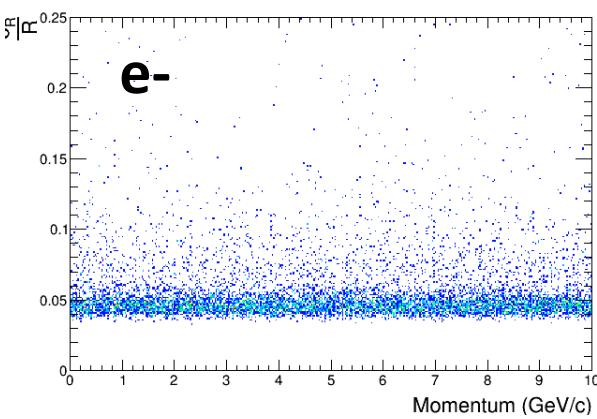
# Detector Performance: Particle ID

- Particles can be identified by correlating the “ring radius” and the momentum.
- Perfect case show that, electron can be identified [0.0, 2.0] GeV, muon [0.4, 2.0] GeV, pion [0.6, 2.0]GeV, kaon [2.3, 10] GeV, proton [4.2, 10] GeV.



# Detector Performance: Radius Resolution

- The “ring radius” resolution calculated is related with the Cherenkov radiation angular resolution. The best resolution can be achieved is  $\sim 5\%$ .



# Summary and Next Step

- Modular concept RICH detector has been constructed using GEMC framework.
- Detector performance are studied at perfect case (no rings finder).
- Need to develop “ring finder” algorithm, and further study the Cherenkov angular resolution, particle identification performance.
- Construct other version of RICH detector in GEMC, and study its performance.